way, the fluoroplastic film **26** (**28**) is adapted to function just like the insulator layer **13** used in the previous embodiments (FIG. **6**-II').

Needless to say, if the fluoroplastic protective film **26** (**28**) is entirely stripped away as in the case shown in FIG. **6**-II, an insulator film **13** may be additionally formed in the manner already described above.

In the foregoing embodiments, the recording head is of a face type in which nozzle orifices **16** are formed in a direction perpendicular to the head face. Obviously, the concept of the invention is equally applicable to an edge-type head which, as shown in FIG. **7**, has nozzle orifices **41** bored through an end face **40** of the head, particularly in the pressure generating chamber constituting member such as an ink channel forming substrate, in such a way that they communicate with the ink channels.

Further in addition, the foregoing embodiments concern the case where the piezoelectric vibrators are formed by a film-deposition technique but, obviously, the same advantage will be attained if a green sheet of a piezoelectric material is cut to shapes that conform to the pressure generating chambers, attached to an elastic sheet and baked to form piezoelectric layers.

As described on the foregoing pages, the present invention provides an ink-jet recording head having piezoelectric vibrators comprising a lower electrode formed on a surface of an elastic sheet providing pressure generating chambers communicating with nozzle orifices, piezoelectric layers formed on a surface of said lower electrode and upper electrodes formed on surfaces of said piezoelectric layers in the areas facing said pressure generating chambers, wherein said upper electrodes are formed independently of each other in the areas facing said pressure generating chambers and wherein an electrical insulator is formed such that it covers an area extending from the peripheral edge portion of the top surface of each of said upper electrodes to the lateral sides of each of said piezoelectric layers, with a window being left intact to provide at least a connection to a conductor pattern. In this design, the upper electrodes are located inward of the pressure generating chambers and are not subject to abrupt displacements at the boundaries of the pressure generating chambers; therefore, the upper electrodes are effectively prevented from being open-circuited. In addition, the piezoelectric vibrators are effectively covered with the insulator layer to prevent not only the occurrence of surface discharge between the upper and lower electrodes but also the deterioration due to moisture absorption.

What is claimed is.

1. An ink jet recording head comprising

an elastic sheet facing pressure generating chambers;

nozzle orifices communicating with the pressure generating chambers;

piezoelectric vibrators formed on the elastic sheet, each of the piezoelectric vibrators having,

a lower electrode formed on the elastic sheet,

a piezoelectric layer formed on the lower electrode, and

an upper electrode formed on the piezoelectric layer such that the upper electrode faces a respective pressure generating chamber, wherein the upper electrodes of the piezoelectric vibrators are positioned independently of each other;

an insulator layer having windows, wherein the insulator layer is formed on a portion of the upper electrodes; and

a conductor pattern connecting with the upper electrodes through the windows of the insulator layer.

2. The ink-jet recording head according to claim **1**, wherein the conductor pattern is formed on a lateral side of the upper electrode between the pressure generating chambers and connected to said upper electrode at more than one site through the windows.

3. The ink-jet recording head according to claim **1**, wherein the windows extend to a peripheral edge of each of the piezoelectric layers such that the windows do not interfere with the displacement of the vibrating region of the piezoelectric layer.

4. The ink-jet recording head according to claim **1**, wherein the insulator layer is made of either one of a silicon oxide, a silicon nitride and an organic material.

5. The ink-jet recording head according to claim **4**, wherein the insulator layer is made of a polyimide.

6. An ink-jet recording head according to claim **1**, wherein the insulator layer is formed of an etchant resistant film which is used as a protective film at etching.

7. An ink jet recording head comprising:

an elastic sheet facing pressure generating chambers;

nozzle orifices communicating with the pressure generating chambers;

piezoelectric vibrators formed on the elastic sheet, each of the piezoelectric vibrators having,

a lower electrode formed on the elastic sheet,

a piezoelectric layer formed on the lower electrode, and

an upper electrode formed on the piezoelectric layer such that the upper electrode faces the respective pressure generating chamber, wherein the piezoelectric layer and the upper electrode are formed entirely inside of areas facing the respective pressure generating chamber;

an insulator layer having windows, wherein the insulator layer is formed on a portion of the upper electrodes; and

a conductor pattern connecting with the upper electrodes through the windows of the insulator layer.

8. The ink-jet recording head according to claim **7**, wherein the conductor pattern is formed on a lateral side of the upper electrode between the pressure generating chambers and connected to said upper electrode at more than one site through the windows.

9. The ink-jet recording head according to claim **7**, wherein the windows extend to a peripheral edge of each of the piezoelectric layers such that the windows do not interfere with the displacement of the vibrating region of the piezoelectric layer.

10. The ink-jet recording head according to claim **7**, wherein the insulator layer is made of either one of a silicon oxide, a silicon nitride and an organic material.

11. The ink-jet recording head according to claim **10**, wherein the insulator layer is made of a polyimide

12 An ink-jet recording head according to claim **7**, wherein the insulator layer is formed of an etchant resistant film which is used as a protective film at etching.

* * * * *

--13. A method of forming an ink jet recording head, comprising an elastic sheet facing pressure generating chambers, nozzle orifices communicating with the pressure generating chambers, and piezoelectric vibrators formed on the elastic sheet by a film deposition technique, said method comprising:

forming a lower electrode on the elastic sheet;

defining a first area in a longitudinal direction of each of the pressure generating chambers;

defining a second area in a width direction of each of the pressure generating chambers;

forming a piezoelectric layer on the lower electrode, and within one of said first area and said second area; and

forming an upper electrode on the piezoelectric layer.

14. A method of forming the ink jet recording head of claim 13, wherein the piezoelectric layer is formed in each of the pressure generating chambers.

15. A method of forming the ink jet recording head of claim 13, wherein the upper electrode is formed in a substantially same shape as the piezoelectric layer.

16. A method of forming an ink jet recording head, comprising an elastic sheet facing pressure generating chambers, nozzle orifices communicating with the pressure generating chambers, and piezoelectric vibrators formed on the elastic sheet, said method comprising:

forming a lower electrode on the elastic sheet;

forming a piezoelectric layer on the lower electrode;

forming an upper electrode on the piezoelectric layer such that the upper electrode faces a respective pressure generating chamber, wherein the upper electrodes of the piezoelectric vibrators are positioned independently of each other;

forming, on a portion of the upper electrodes, an insulator layer having windows; and

forming a conductor pattern connecting with the upper electrodes through the windows of the insulator layer.

17. A method of forming the ink-jet recording head according to claim 16, wherein the conductor pattern is formed on a lateral side of the upper electrode between the pressure generating chambers and connected to said upper electrode at more than one site through the windows.

18. A method of forming the ink-jet recording head according to claim 16, wherein the windows extend to a peripheral edge of each of the piezoelectric layers such that the windows do not interfere with the displacement of the vibrating region of the piezoelectric layer.

19. A method of forming the ink-jet recording head according to claim 16, wherein the insulator layer is made of either one of a silicon oxide, a silicon nitride and an organic material.

20. A method of forming the ink-jet recording head according to claim 19, wherein the insulator is made of polyimide.

21. A method of forming the ink-jet recording head according to claim 16, wherein the insulator layer is formed of an etchant resistant film which is used as a protective film at etching.

22. A method of forming an ink jet recording head, comprising an elastic sheet facing pressure generating chambers, nozzle orifices communicating with the pressure generating chambers, and piezoelectric vibrators formed on the elastic sheet, said method comprising:

forming a lower electrode on the elastic sheet;

forming a piezoelectric layer on the lower electrode;

forming an upper electrode on the piezoelectric layer such that the upper electrode faces the respective pressure generating chamber, wherein the piezoelectric layer and the upper electrode are formed entirely inside of areas facing the respective pressure generating chamber;

forming, on a portion of the upper electrodes, an insulator layer having windows; and

forming a conductor pattern connecting with the upper electrodes through the windows of the insulator layer.

23. A method of forming the ink-jet recording head according to claim 22, wherein the conductor pattern is formed on a lateral side of the upper electrode between the pressure

generating chambers and connected to said upper electrode at more than one site through the windows.

24. A method of forming the ink-jet recording head according to claim 22, wherein the windows extend to a peripheral edge of each of the piezoelectric layers such that the windows do not interfere with the displacement of the vibrating region of the piezoelectric layer.

25. A method of forming the ink-jet recording head according to claim 22, wherein the insulator layer is made of either one of a silicon oxide, a silicon nitride and an organic material.

26. A method of forming the ink-jet recording head according to claim 25, wherein the insulator is made of polyimide.

27. A method of forming the ink-jet recording head according to claim 22, wherein the insulator layer is formed of an etchant resistant film which is used as a protective film at etching.

28. A method of forming the ink jet recording head according to claim 13, said method further comprising:

forming, on a portion of the upper electrodes, an insulator layer having windows; and

forming a conductor pattern connecting with the upper electrodes through the windows of the insulator layer.

29. A method of forming the ink-jet recording head according to claim 28, wherein the conductor pattern is formed on a lateral side of the upper electrode between the pressure generating chambers and connected to said upper electrode at more than one site through the windows.

30. A method of forming the ink-jet recording head according to claim 28, wherein the windows extend to a peripheral edge of each of the piezoelectric layers such that the windows do not interfere with the displacement of the vibrating region of the piezoelectric layer.

31. A method of forming the ink-jet recording head according to claim 28, wherein the insulator layer is made of either one of a silicon oxide, a silicon nitride and an organic material.

32. A method of forming the ink-jet recording head according to claim 31, wherein the insulator is made of polyimide.

33. A method of forming the ink-jet recording head according to claim 16, wherein the insulator layer is formed of an etchant resistant film which is used as a protective film at etching.

34. A method of forming the ink jet recording head according to claim 13, said method further comprising:

forming, on a portion of the upper electrodes, an insulator layer having windows; and

forming a conductor pattern connecting with the upper electrodes through the windows of the insulator layer,

wherein the piezoelectric layer and the upper electrode are formed entirely inside of areas facing the respective pressure generating chamber.

35. A method of forming the ink-jet recording head according to claim 34, wherein the conductor pattern is formed on a lateral side of the upper electrode between the pressure generating chambers and connected to said upper electrode at more than one site through the windows.

36. A method of forming the ink-jet recording head according to claim 34, wherein the windows extend to a peripheral edge of each of the piezoelectric layers such that the windows do not interfere with the displacement of the vibrating region of the piezoelectric layer.

37. A method of forming the ink-jet recording head according to claim 34, wherein the insulator layer is made of either one of a silicon oxide, a silicon nitride and an organic material.

38. A method of forming the ink-jet recording head according to claim 37, wherein the insulator is made of polyimide.

39. A method of forming the ink-jet recording head according to claim 34, wherein the insulator layer is formed of an etchant resistant film which is used as a protective film at etching.--